OBSERVATIONS

ON THE

CULTIVATION OF ORGANIC SCIENCE,

BEING

THE HUNTERIAN ORATION

DELIVERED FEBRUARY 14, 1848, BEFORE

THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

BY

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LECTURER ON GENERAL ANATOMY AND PHYSIOLOGY
AT ST. THOMAS'S HOSPITAL.

"The invisible things of Him from the creation of the world are clearly seen, being understood by the things that are made, even His eternal power and Godhead."

LONDON:
SAMUEL HIGHLEY, 32, FLEET STREET.
MDCCCXLVIII.

"Duæ viæ sunt, atque esse possunt, ad inquirendam et inveniendam veritatem. Altera à sensu et particularibus advolat ad axiomata maxime generalia, atque ex iis principiis eorumque immota veritate judicat et invenit axiomata media: atque hæc via in usu est. Altera à sensu et particularibus excitat axiomata, ascendendo continenter et gradatim, ut ultimo loco perveniatur ad maxime generalia; quæ via vera est, sed intentata."—Bacon.

C. AND J. ADLARD, PRINTERS,
BARTHOLOMEW CLOSE.

TO

BENJAMIN TRAVERS, ESQ. F.R.S.

PRESIDENT OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

My dear Sir,

My leading object in the present Address having been to set forth the advantages derivable from the philosophic investigation of Organic Science, I know no name that could with more propriety be prefixed to such an attempt than your own, allied as it inseparably is, in our profession, with some of the most successful efforts that have yet been made, to elevate and dignify the study of Surgery, by impressing upon it the characters of a scientific pursuit.

I remain, my dear Sir,

With great esteem,

Your's faithfully,

R. D. GRAINGER.

March 20, 1848.

HUNTERIAN ORATION,

1848.

Mr. President and Gentlemen,

It would, in the present period, be a work of supererogation to expatiate on the high merits of that illustrious man whose natal day we are assembled to commemorate. The lapse of time, no less than the eloquence which has in this place been so often inspired by the theme of Hunter's genius, fortunately has relieved me of some slight portion of the difficulty I have experienced in the assumption of an office which, in the capacity of President of this College, you, Sir, have been pleased to commit to my charge. Freed from the limitations of an obligation which, until it had been discharged in each and every one of its requirements, must have operated on my predecessors as a prohibition to all other topics, a wider field for selection lies before me. But although all formal eulogium on the great founder of scientific physiology, as well as of enlightened surgery, would now be misplaced, yet it is, perhaps, one of the highest glories of Hunter, that in proportion as the philosophic culture of organization has advanced, he who would attempt to record its progress, and especially to trace

out the causes that have led to it, must ever and again return to him as to a beacon, which, in place of being obscured by waning years, has only shone forth in all its fulness and significance in these late and advanced times. I need not, gentlemen, point out to your notice that this is the very mark and characteristic of high genius; nor that it has happened in every department of human knowledge, that the great luminaries, who, at their stated intervals, have come forth to instruct and enlighten mankind, have rarely found their contemporaries in a state sufficiently advanced even to comprehend their glorious truths when set before them. In this respect HUNTER formed no exception: for it is quite clear, as we can at length perceive with the latest aids of science, that he neither was, nor could be, understood in the time in which he lived. I know not how others have been affected in this matter, but having, from the nature of my pursuits, been called upon carefully to watch and to scrutinize the progress of organic science, there is no one circumstance that has so forcibly excited my surprise, need I say my admiration, that, amidst the innumerable additions that have from all quarters flowed in, there are scarcely any which do not find their place among the great principles announced by HUNTER; while not a few of the most profound discoveries, equally with the most minute, are but the repetitions of truths which he had long since proclaimed in a language now become clear and expressive.

The progress of modern physiological science being thus in harmony with the spirit of our great master's labours, it has occurred to me that it would not be altogether foreign to the design of this anniversary meeting, if some review were undertaken of the more important causes which have secured an advance so remarkable; especially as an opportunity would thereby be afforded

of inquiring into the means of investigation best adapted to facilitate the study of a science, so intimately associated with that profession to which it is our high privilege to belong. Although vividly impressed with my own insufficiency to do justice to a subject so comprehensive, I am induced, by a conviction of its utility, to enter upon this exposition ; to which, indeed, I am the more strongly impelled by an impression which has long forced itself on my mind, and I think it may be affirmed that this is a conviction shared by several of those who have either aided in widening the limits of organic science, or who have been observant witnesses of their rapid extension, that, owing to some cause or other, the acquisitions of the last few years have, in more than one quarter, been either undervalued, or have not commanded that prominent degree of attention to which it is conceived they are so pre-eminently entitled.

It is not, perhaps, so remarkable, considering the apathy that prevails among the general public in all that relates to our profession—and most unhappy is it for the highest interests of society that so it should be—that the great discoveries both in physiology and anatomy, which are crowded within the last quarter of a century, have attracted so little notice among even the educated and learned classes. And yet it would not be difficult to show that, within the space of these few short years, the whole aspect of organic science has been changed ; that discoveries, in no degree second in intrinsic importance to that of the circulation, have been made, casting a flood of light on the most universal phenomena of animal bodies ; that generalizations, relating both to properties and laws, having a value and a signification in the organic creation so vast, that they can only be properly compared with those of gravitation or chemical affinity in the domain of common matter, have been firmly established ;

that, whereas, till within a period so brief, that it is as nothing in the ordinary calculations of human progress, there was scarcely a prime question, relating whether to structure or function, which was not either unknown or involved in doubt, there are now few on which a mass of knowledge is not possessed, which, even by the most sanguine, must have been hoped for, rather as the fruits of centuries than of years.

Whilst these great things have been accomplished, as it will be my object to prove, in our own science, we may look around and doubt whether, notwithstanding the multitudinous and splendid achievements of chemistry and physics, any one discovery in any one branch of knowledge, within the limits I have assigned, can be cited as equalling, in universality of application, or in fruition as to results, the law of nervous conduction established by the genius of a BELL, or the principle of cell-formation, mainly elucidated by the labours of a SCHWANN.

If all that is here averred is susceptible of distinct and indisputable proof; if, moreover, it can be made apparent that not only has this magnificent and, the time considered, unparalleled advance been secured; but, which is a point of even more promise for future progress than the mere acquisition of any amount of knowledge, that the mode of the investigation has been changed, and placed in harmony, in this respect, with the other inductive sciences; if, that is to say, the cultivators of modern physiology have, in order to become the interpreters of Nature, resolved to appeal to herself; if all this has been accomplished, it will not, I trust, be deemed altogether a profitless occupation, if inquiry be made how results of this superlative value have been obtained.

Thus impressed, I can only hope, gentlemen, that I may find in your candid liberality an excuse for the many

omissions your information will but too readily enable you to detect, and a palliation for those errors which will, I fear, become too apparent to your discriminative judgment.

The only plea, personal to myself, that I can urge as a reason for thus adventuring into so complex a question, and for avoiding the charge of presumption, is, that having, from the nature of my engagements, been called upon to weigh the comparative value of the knowledge formerly current in the schools with that of the present day, I may, in some degree, be presumed to have had a favorable opportunity for forming a correct estimate; and inasmuch as I participated myself for a time in the method of investigation formerly adopted, I may, with the less reserve, point out what, on a candid review, may appear to have been its deficiencies and errors.

The subject thus selected for our consideration requires that, in the first place, the existing state of knowledge, immediately preceding the epoch I have indicated, should be briefly examined, in order that the subsequent advance may be set forth in its true light. But to do this with advantage, it will be necessary that we should well discriminate between that information which was positive and indisputable, and that which, although known in part, was mixed up, more or less, with the elements of doubt and uncertainty; for, unless this distinction be carefully kept in view, the estimate ultimately arrived at will neither be consistent with truth, nor subservient to utility. In such a review it is moreover of special moment that the pervading tone of thought, as reflected in the systematic writings at the period immediately antecedent to what it is, perhaps, no misnomer to designate as the revival of physiological science, should be closely scrutinised.

Having these objects in view, it will soon become

apparent to the careful observer that the most striking feature of the anatomy and physiology of the period indicated,—I exclude of course mere elementary details,—may be characterised by the term uncertainty: whenever the investigation overstepped the limits of the more obvious and readily appreciated facts, contradiction and doubt began to prevail. So remarkably was this the case, that it would not have been difficult to have separated the positively known from the unknown in structure by drawing a line between the visible, and, to the unaided eye, the invisible; and, in like manner with respect to function, to have distinguished between the certain and the doubtful by parting off the obvious and subordinate acts from the subtle and essential. That there were many notable exceptions to both these propositions is most true; but still they were the exceptions, and not the rule.

It would be altogether incompatible with the object of this rapid retrospect, to enter into the detailed proof of the propositions here set forth; this must be sought in the literature of the day. It must suffice now to state that nothing was known with certitude of the ultimate, that is, the essential structure of any one class of organs in the body: the true structure of bone, of cartilage, of muscle, of nerve, of the epithelium and its allied organs, of the various pigmental tissues, all this was unknown; nor did the vague guessing at the conformation of the whole glandular apparatus, or the speculations as to the relations existing between the vascular system and the solid tissues of the body, afford any more real help in determining the great cardinal questions of secretion, absorption, and nutrition.

Of one of the most philosophic branches of anatomy having ramifications and applications throughout the whole organic creation, embryology, so little was known,

and that so much mixed up with doubt and obscurity, that no useful generalizations could be established; and thus it happened that, until the discovery of the mammiferous ovum, one of the most important means of interpretation, inclosing such glorious truths, remained all but a sealed book.

If from the anatomy we turn to the physiology of the epoch immediately preceding the establishment of Bell's great discovery, we shall find that although there was a large assemblage of most valuable facts, and likewise that several of the laws connected with the vital phenomena were more or less accurately determined, there was yet in many fundamental questions a large admixture of doubt and uncertainty. I must here again, in support of this assertion, confine myself to a single illustrative corroboration, that of the gastric juice. What were the organs for its secretion? did these consist of the glands of the stomach, or of what were called the exhalent vessels? was it, therefore, a glandular liquid or a perspired fluid? was it acid, or alkaline, or neither one nor the other? if acid, did the acidity depend on its inherent qualities, or on the acetous fermentation of certain kinds of aliment? was it constantly poured out, or only when the stomach was excited by the presence of food? These and similar questions were again and again proposed, but to them science gave in those days no certain response; and so it happened that although chemists had obtained and analysed the gastric secretions, although anatomists had scrutinised the structure of the organ, and physiologists had even looked into the interior of the living human stomach, all remained in obscurity and doubt till the admirable researches of Prout, Eberle, and Schwann, joined to the capital experiments of Beaumont, and the anatomical investigations of Boyd and Bischoff, threw a clear and steady

light upon this, one of the most recondite phenomena of the animal economy.

But I hasten to consider the second point suggested for notice in this retrospect,—the tone of thought at the time indicated.

It would be superfluous in this enlightened assembly to dwell on the fact, that amidst the varied circumstances that have contributed to the vast progress of modern science, that which has exercised the one predominating influence has been the assured and unshaken conviction, that the only true mode of investigating the multitudinous phenomena of nature, whether physical or vital, is by regarding them as regulated by unity and law. In the case of organic science there is, however, another great principle, that of final causes or design, in no degree subordinate to either of the preceding, but whose vast importance, as elucidative of the most comprehensive truths, is, notwithstanding the rich fruits it has yielded in the hands of a CUVIER or an OWEN, not even yet fully recognised.

Now, Sir, I think we may affirm, without in any the least degree wishing to disparage the labours of former investigators, that this triple combination of design, unity, and law, was not kept sufficiently in view in the researches illustrative either of structure or function; that in a study abounding above all others in subtle, diversified, and intricate phenomena, the neglect or violation of axioms long regarded as essential in the inquiries of astronomical science, and, in later years, in those of chemistry and geology, was productive of the greatest confusion and uncertainty; that, in fine, of all the causes that have obstructed the successful cultivation of organic science, the most influential one has been the custom of regarding the phenomena and laws of living

bodies as being altogether so peculiar, as to require a mode of investigation different from that applied in the other great departments of knowledge. The history of every branch of organic science, testifies to the mischief that has accrued from the subversion of one or other of these fundamental principles. Thus the celebrated question, so long agitated between the school of CUVIER and the followers of that distinguished zoologist, GEOFFROY ST. HILAIRE, turned essentially on some supposed incompatibility of unity of plan with design in detail; so that whilst one set of controversialists were scrupulously careful not to ascribe to the Supreme Intelligence any intention or purpose in the organization of animals, thereby not only contravening the plainest dictates of common sense, but also yielding up one of the most fruitful means of interpretation, the other party, in its anxiety to prove, what must be the final solution of the discussion, that every animal, both in its parts and in its totality, is formed strictly in reference to the part it has to play in the economy of nature, overlooked, in some degree, that pervading unity of which the traces are discoverable, beneath all the modifications of form and texture, however varied or peculiar these may be. Now it would not be difficult to show, that neither the one nor the other of these widely-spread opinions, in the form they have usually assumed, can be received as strictly correct. Anatomy, whether human or comparative, overflows, indeed, with proofs of the opinion so ably advocated among others by the learned historian of the Inductive Sciences, that the modern doctrine of Unity of Plan in different kinds of animals does not at all necessarily contradict that of Final Causes; or, in other words, that Morphology is not inconsistent with Teleology. One illustration only in support of this position, and that of very obvious application, can here be adduced. Every

one is acquainted with the striking peculiarities presented in the bones of the various classes of the vertebrate animals: that in some, as in fishes and certain reptiles, they are solid; that in others, as in birds and mammals, they are hollow; that in one class they contain oil, in another marrow, in a third air. No one who has considered the details of these modifications, can regard them as being aught else than adaptations to special modes of existence: this, then, is Design. But the embryologist, who concerns himself more with primary or typical than with secondary or adapted forms, knows that whatever is to be the character of the future organ, whether excavated into vast labyrinths of sinuses, as in the skull of the elephant, or permeated with air even down to the minute phalanges, as happens in some birds, the primeval bone is invariably, and without exception, solid: this is Unity.

If, however, all this be granted; if it be admitted that this combination of unity and design be in reality displayed in the organization of animals, the conclusion may, to some persons, appear to be of little moment to the members of our own profession. But experience indicates the contrary; for it teaches us that the doctrines of comparative anatomy have always exerted, and with great reason, a decided influence on the leading questions of human anatomy and physiology; nor does the epoch to which I am referring form any exception to this general position. It would not be difficult to show, if time permitted, that the writings of CUVIER in reference to the typical characters of the nervous system, by inculcating the doctrine that the invertebrata had, in this respect, nothing in common with the vertebrata beyond the brain, exerted, in former years, a most unfavorable influence on this interesting branch of physiological science.

In addition to the obstruction offered by the inattention to fixed laws indicated by the preceding remarks, it cannot, I think, be doubted that another circumstance which exerted an unfavorable influence was this—that the modes of investigation then proposed were, if the expression may be permitted, too coarse; or, in other words, that the means adopted were not adjusted to the extreme subtlety of that which constituted the subject matter of the inquiry. This is the more remarkable, when the beacon held forth by the great anatomists of the two preceding centuries, and the splendid results to which their philosophic procedure directly led, are called to mind.

One of the most injurious consequences of this departure from the right track, was that anatomists no longer regarded the great end of all their inquiries to be the discovery of the ultimate organic structures; and it hence followed naturally that microscopic research and chemical analysis, two of the principal instruments for the attainment of that end, attracted little or no attention.

This indifference to minute anatomy probably gave a tinge to physiological investigation, so that, neglecting the penetrating and subtle questioning to which nature must ever be subjected, if her ultimate truths are to be reached, the physiologist too often halted at that outer and more obvious circle of secondary phenomena, within which lie the true primary forces of all vital action. It is to such a frame of mind that many of the fundamental errors formerly prevalent may, with propriety, be attributed. Thus, in the case of secretion, as the most palpable phenomena are those concerning the circulation and distribution of the blood, it became the established opinion that the small arteries, now known to be merely the carriers of the nutrient fluid, were, instead of the more refined apparatus of the epithelial cells, concealed

beneath them, the efficient agents in the process; in the same way as in absorption, the lymphatics were regarded as the primary instruments of removal, because it was ascertained that they bore off the débris of the organs. The consequence of a state of things thus opposed to the condition of all decided progress was, that, notwithstanding the general perception of innumerable voids in all the higher branches of organization, writers contented themselves either with attempting to fill up the deficiencies by speculations, which, wanting a sufficiently wide basis of facts, were but too often crude, or absolutely false; or, by affirming, without any distinct perception of the means by which it might be made successful, the necessity of further investigation.

It is difficult to conceive of a condition more anomalous or unpromising than this, in which so much was uncertain or contradictory; where, in the absence of clear and well-defined objects of pursuit, and wanting the guiding aid of firmly-established general laws, both the teacher and his pupils, to borrow the language of the philosophic Oken, were blindly and laboriously groping about in the dense labyrinth of facts; where, in fine, the accumulated but not perfect knowledge of two centuries had been either so distorted, or so ill interpreted, as to have become, in many prime questions, not only almost useless, but even to have created, especially in this country, doubts as to the trustworthiness of what are now recognised to be the most valuable means of research.

In approaching the second topic, I have to consider the present aspect, that is to say of organic science, the objects that present themselves, owing to the rapid progress in each and every department, are so numerous and varied, that I must content myself with a selection of a few of the more striking and instructive.

There are, Sir, in the first place, some general features by which, as I would submit, anatomical and physiological science, as contrasted with its former state, is eminently and advantageously distinguished. The most important of these is the comprehensiveness of its range. It is no longer proposed to cultivate the human organization by any one, or two, or three of the methods formerly applied, to the exclusion of the remainder. Anatomists, for example, are no longer satisfied with an examination of the human body alone, nor with appealing merely to comparative anatomy; nor do they confine themselves exclusively either to microscopic exploration, to embryology, or to chemistry: all these means of research are made subservient to the great end in view. The physiologist, again, feels himself called upon to appeal to the general properties and laws of all matter, whether inorganic, vegetable, or animal; he does not rest exclusively either on physics, chemistry, or life; but, in order to construct a rational theory on any one vital phenomenon, he selects and combines the elements which each of these great departments supplies. If it be objected that there is nothing new in any of these methods, that may be perfectly true, if by this it is meant to indicate them singly, or even to some extent combined, or as having been distributed among the various schools that have at different times arisen; but it would be difficult to point to any period or to any country, in which all the means now employed by universal assent in the investigation of structure, and in the interpretation of function, were directed to the same purposes.

The second favorable characteristic to which I would point is the more just conception of the relations that ought to exist, between the employment of the senses and the exercise of the purely intellectual faculties. This combination, now so well appreciated, has often been

overlooked. Thus a celebrated English physiological writer, in the earlier part of the present century, did not hesitate, in an inquiry into one of the most subtle of the animal forces, that of the muscles, to express his opinion that the structure of the organs implicated was an unimportant element in the question.* Now although no one can be more ready to admit than myself the necessity of emancipating the mind from the bondage of the senses, yet it is clear that where, as in the animal organism, the most intricate and refined arrangements of matter are concerned, far surpassing the preconceived and often gross conceptions of the human intellect, nothing short of the most scrupulous and repeated questionings of nature, such as those now practised in every part of Europe, can afford any reasonable ground of success. But in addition to the great utility of the facts in themselves, as thus obtained, they have, collectively, a much higher application; they are most suggestive as regards discovery, and often, by converging, as it were, to a common point, they carry the mind so near to some yet hidden truth, that at length the

* The scientific writings of the author to whom reference is here made, Mr. Abernethy, are strikingly illustrative of the defective method so often adopted in former times in physiological research; they also show the utter confusion then pervading the higher departments of organic science. At a period when, as this esteemed author was at some pains to show, the true structure of the muscles and nerves was so totally unknown as to lead him to the supposition that the ultimate arrangement of organized matter might be, like its ultimate particles, a subject too subtle for human perception, he was not thereby deterred from entering hastily and precipitately into the most abstruse problems that are presented to the human mind—the nature of life, and the principle of the muscular and nervous forces. These, and similar barren speculations concerning the ultimate truths of physiology, resting on no basis of previously ascertained facts, and violating all the laws of inductive reasoning, have ever been the bane of this science, not merely by inculcating error, but still more by diverting attention from the only true mode of investigation—extended observation and cautious generalization. I trust it is not necessary I should disavow any desire to detract, by these remarks, from the just claims of the late Mr. Abernethy, as a most distinguished and scientific surgeon.

glorious light flashes out on the mental eye. This is, indeed, the only way in which great truths are ever made out in physical science, and thus it has always been that the great promoters of true knowledge have been industrious observers. That some men of elevated genius have been enabled at long intervals to overleap, to a certain extent, the barriers of matter by the force of their intellect alone, is most true; and we have, in the history of our own science, two instances of such triumphs, as brilliant as any that can elsewhere be adduced. Neither HARVEY nor BELL saw with the bodily organ the great cardinal facts they so confidently proclaimed—the junction, that is to say, in the one case, of the arteries and the veins by means of the capillary vessels, that subtle link in the circle of the blood, and in the other the individuality of the primary nervous tubules.* But the means for the cultivation of science must be adapted to its daily progress and to ordinary abilities, not to these exceptional cases, which occur at intervals of centuries to excite the wonder and the admiration of mankind.

Another valuable characteristic offered by the present aspect of physiology is freedom of opinion. Notwithstanding the loosening of the many shackles by which the intellectual sphere was formerly hampered, it is clear

* Having taken a deep interest in the discoveries connected with the nervous system, I was anxious to know if Sir C. Bell had ever examined the nerves with the microscope, this being of course the only method by which the disposition of the primitive tubes could be actually seen. My own impression always had been, that he had not done this; but that what he so urgently insists on as being, to use his own expression, the key to the whole system, the independence, namely, of these filaments, he had only seen with the mental eye. This conviction is confirmed by the near relative of this illustrious physiologist, Mr. A. Shaw, who, in a communication with which he has favoured me, states confidently that Sir C. Bell never used the microscope with the view of tracing the fibres; that, in fact, he never saw, save by the mental eye, the primitive nerve-tube.

that, even in the nineteenth century, the cultivators of anatomy had not sufficiently freed themselves from the undue pressure of authority. How otherwise can it be explained, for instance, that for more than 150 years it was conceived necessary to receive either the hypothesis of MALPIGHI, or that of RUYSCH, or even both together, on the glandular structure, although neither of them was correct. But in enumerating as a promising characteristic the free range now given to mental speculation, this can only be understood as implying the severe control afforded by repeated appeals to Nature; liberated from this wholesome check, theory and hypothesis, instead of being, as they now are, the very handmaids of discovery, and that even when mingled, as so often happens, with some particles of fallacy, would degenerate, as heretofore, into idle guesses or empty dreams.

Among these general considerations, it is only necessary to allude to one other great change that has been brought about by the zeal of the present day: it is the air of certainty that has been impressed upon many of the cardinal questions of organization. Although a vast field remains to be explored, although many points relating even to objects which it is evident are adapted to successful observation, are yet involved in doubt, still it will become apparent to all impartial observers that, compared with the endless confliction and confusion of former days, we have emerged into a region of light, in which objects, even though distant and far off, are at least presented in a comprehensible and intelligible form.

With these few remarks, illustrative of the tone prevailing among the cultivators of organic science at the present time throughout Europe, I proceed to point out some of the acquisitions actually realized in late years.

Foremost among these may be placed all those valuable and varied investigations which have disclosed, in so many instances, the intimate structure or formation of the several organs. There are, indeed, some persons who doubt, as I have already stated, the necessity for all this minute research; and this being so, the present appears to be the most fitting place for considering the merits of this question.

It may be affirmed as a general proposition that in no one instance can the real nature of a vital action be thoroughly comprehended, unless anatomy previously has revealed the ultimate construction of the part or instrument implicated; any description which falls short, even in the minutest particular, of this desideratum, will not afford the conditions for a true interpretation. Now, Sir, it is precisely in this respect that modern science excels; for it is remarkable, that although the great anatomists of former times had so often approached the final limit, they had, almost without an exception, failed in the last essential step. The illustrations of this position are numerous and indisputable; among them I may select the muscular substance, which has of late years been so successfully illustrated, especially by a most accurate observer and admirable physiologist, Mr. Bowman. It has at length become evident that the last refinement of microscopic research was requisite to reveal those facts which promise, in this advanced age, to solve one of the greatest mysteries of animal existence—the nature and cause of muscular contraction. It will be perceived I here allude, first of all, to the significant fact that the ultimate fibril is made up of either of two substances, distinct in their chemical constitution, or of two forms of the same substance, in different states as to molecular arrangement, the difference being indicated by difference of refractile power; and, secondly, to that equally im-

portant fact, that these sarcous elements are inclosed in exquisitely delicate but still distinct cells. These subtle distinctions, relating to the existence of three differently constituted substances in an object of about the 18000th part of an inch in its shortest diameter, will convey a striking illustration of the penetration and accuracy of the present anatomy. But they will do more; for they show that the microscope goes far beyond that science to which many look, and with justice, as one of the great instruments for the future advancement of physiological knowledge—organic chemistry; and although it is true only a diversity of matter is indicated, the exact nature of which will doubtless be determined hereafter by analysis, still the distinction noticed, joined to the very interesting resemblance pointed out by my friend Dr. Todd, as existing between this pile of muscular cells and the electric organ of the torpedo, and of other similarly endowed fishes, and especially when viewed in connexion with the deeply interesting experiments of Matteucci, must be regarded as an element of some moment in the further prosecution of this great question.

I now approach, Sir, a series of observations which, within the brief space of twenty years, have wrought even a more marked change in the whole circle of actions belonging to the vegetative life, than that accomplished in the sphere of the animal functions by the admirable researches of Bell. These investigations are indeed so comprehensive, embracing as they do both the great domains of the organic creation; the doctrines built upon them are so subversive of former opinions, and must, if firmly established, give an impulse so entirely new to all future investigations, as to justify, on an occasion like the present, a careful review of the grounds on which they rest. The great principle sought to be

educed by the new school of physiology, is this—that in all organized beings, whether vegetable or animal, vascularity is secondary and subordinate, not primary or essential; that it may therefore be altogether dispensed with, as it is affirmed is the fact not only in the lower plants and animals, where the absence of vessels is admitted, but also in the early embryonic condition of all, including the highest classes of animals, the human being forming no exception. It is also maintained, that in morbid processes, involving acts of assimilation, deposition, and absorption, the agency of the vessels is, as in the normal state, indirect, and in subjection to other and preceding processes.

In a question like this, it would be vain to attempt any definition of the ultimate nature of the vital forces, or to determine the exact manner in which they are related to the matter of organic bodies. Nor need this either surprise or discourage the student of physiology, for the same difficulties beset the path of the natural philosopher. If we may judge by the tone of argument assumed by some of those who have written on this subject, it might indeed be supposed that all the difficulties attendant on the investigation of natural phenomena were connected with those of life, whereas the reality is that we know just as much of the vital forces as we do of the physical. Who, for instance, knows anything of the nature of light, of heat, of electricity? or, who can assign their intimate relations with the material substances necessary to their manifestation? But, as the want of this knowledge has been no barrier to the successful investigation of the conditions, laws, and effects of these subtle physical forces, so the absence of all acquaintance with the abstract character of the vital powers need be no obstacle to the most searching examination of the question now before us.

It is no trifling advantage in an inquiry of this admittedly difficult character, that the advocates of the new physiology can claim in support of their doctrines the high authority of HUNTER. But to derive the full benefit of the profoundly systematic writings of this great luminary of science, it is indispensably necessary that these should be well weighed and thoroughly comprehended. Now, although it may probably appear a bold assertion, yet the interests equally of truth and of justice demand the avowal, that the state of physiological knowledge, till within a very recent period, did not allow of such a scrutiny being successfully applied; for, in his views respecting both the vitality of the organic fluids and the existence of organization independently of vascularity, HUNTER was so much in advance of his age, that it required the lapse of nearly half a century justly to appreciate the aim and scope of his arguments.

Partly owing to this circumstance, and partly in consequence of the abstract and metaphysical disputes which have, to the great injury of science, been introduced into the discussion, it at length came to pass that some physiological writers, in considering the claims of HUNTER to the admiration of posterity, have not hesitated to affirm that the facts accumulated by his industry will constitute the basis on which his fame will ultimately repose; and that these will remain when his speculations will be forgotten. These strange assertions render it desirable to show that it is precisely these depreciated speculations, or rather, as in justice they ought to be termed, these splendid generalizations, touching the relations and laws of vital forces, which have now, as they will hereafter have, the highest claims to the notice and the admiration of the student in physiology. That some of these views were, from their character, difficult of apprehension, and that others were obscured by an infelicity

of language, may be readily granted; but it must not be forgotten, that science sustained the irreparable loss of never having the collected and elaborated conceptions of HUNTER'S genius, on some of the highest subjects that can engage the human mind.

Freed from these extrinsic circumstances, and dismissing for the time the question of the ultimate nature of the vital forces, there is no difficulty in comprehending, with the more exact knowledge of the present day, that HUNTER had a clear perception of two of the most important principles connected with the science of organization: first, that vital forces are not restricted to the solids, but also are possessed by, or are displayed in, the fluids of the animal body, and especially by the blood; second, that vital forces are possessed by, or are observed in, parts of the body which are non-vascular.

Reasoning in support of the first and most fundamental of these propositions, he is particularly concerned plainly to demonstrate, that the mere form assumed by matter has no influence whatever on the essential properties, although, as one of his commentators truly remarks, we are, from habit, more accustomed to connect the idea of life with a solid, than with a fluid. In the treatise on the Blood these principles are set forth in this profound and significant passage: "In all matter the property does not depend upon structure, or configuration, but upon the compound," or essence, as it might be termed. This axiom I may, for the occasion, thus illustrate: the compound matter called water, composed of two volumes of hydrogen and one volume of oxygen, may be either in the solid, liquid, or gaseous form; and yet, although the secondary qualities are different in each state, so that ice is solid and resisting, water liquid and mobile, and steam elastic, in each of these forms the fundamental nature remains unchanged. And so it is

with respect to living substances; these may be either solid, as the tissues, or liquid as the blood, and this last may be either fluid whilst circulating, or solid after coagulation within the body, and yet retain its essential, vital endowments. The extended and minute researches of modern observers leave no room to doubt the entire truth of this all-important doctrine. The fact of its ever having been questioned, is a proof of the difficulty the mind has even of conceiving of the more subtle relations of the vital forces with matter. Apart from this innate dullness, there is no more reason why we should hesitate to admit the alliance between an organic liquid and vitality, than between this last and an organic solid.

Again, there is now no difficulty in comprehending what the penetrating mind of HUNTER was aiming at when he affirmed, in relation to the transplantation of the teeth, that the living principle exists in the several parts of the body, independently of the influence of the brain and circulation; that in proportion as animals have less of brain and of circulation, the living power has less dependence on them; and that in many animals there is no brain nor circulation; indeed it would be impossible for any physiologist of the present day, with all the accumulations made since these principles were first enunciated, to give a more precise or accurate definition of the true relations of vitality.

The leading fact in support of which I have adduced the authority of our great master, is, that organization is essentially and invariably independent of vascularity. The more precise and detailed information upon which the universality of this truth at present rests, dates from the important fact discovered by DUTROCHET, that if two liquids of different densities, and not inclined to combine chemically together, be placed on the opposite sides of a thin organic membrane, a double current is set up,

according to certain laws, till intermixture is effected. This phenomenon, which was denominated by the author of the discovery endosmose, was supposed by him to have a marked influence on the movement of the organic fluids. Up to this time, however, no apparatus was known in animals to be superadded to the vessels, which were therefore supposed to be the immediate agents of all secretion, absorption, and nutrition; but, when the great discoveries of SCHLEIDEN, SCHWANN, and HENLE showed that wherever secretion or absorption, or nutrition was going on, there was organic membrane interposed, either in the form of nucleated cells, or in that of the epithelia of the glands, or in the character of delicate sheaths, as in the sarcolemma of the muscles, the prior researches of DUTROCHET assumed a much higher significance, as offering a probable explanation of that double current, which, whatever may be its real nature or amount, must be incessantly going on in the molecular actions of nutrition. How clearly with the new light concerning extravascular action, do we perceive the reason of that double error, which so long served for the contention of two leading schools of physiology; the one class of disputants affirming that parts, wanting vascularity like the epidermis, were therefore inorganic; whilst the other, objecting to the position that any part of a living body could be otherwise than organized, contended that the vessels were the only agents by which this could be effected.

In consideration of the vast importance of the now generally received doctrine respecting the nutritive action, I may, perhaps, be excused for the introduction of one well-marked illustration. The instance I would select is that furnished by the process of development or formation of the new being; and, in order to prevent any supposition that vessels might be in some way or other

operative, if the mammiferous ovum were chosen, the egg of the bird may be adduced. When this quits the parent animal it has no trace of blood-vessels whatever; by the influence of incubation the minute germ begins to be developed; an important organized structure, the germinal membrane, is formed; the rudiments of the nervous centres are laid down; the primordial vertebral column is traced out; the commencing alimentary canal appears; and all these elaborate acts of organization, comprising the absorption of nutrient matter, its elaboration and deposition, are accomplished before a single blood-vessel has made its appearance.

This being so, we may be assured the essential character of nutrition is never subsequently altered by the mere fact of vessels being superadded; such an admission, indeed, would be in total opposition to that exquisite harmony and rigid unity which are displayed by the organic laws. Some individuals who might not object to this conclusion in respect to healthy nutrition, would perhaps still entertain doubts when it is a question of disease. It may not, therefore, be superfluous to state, there is ample evidence to prove that the laws of abnormal nutrition are fundamentally the same as those of the normal action; that, for example, in the case of the cornea, a highly-organized but non-vascular body, an ulcer may be formed, may be filled up, and perfectly healed, remaining, even as is seen in some instances, quite transparent throughout the whole process, and certainly, as my friend Mr. Dixon has expressly ascertained at the Ophthalmic Hospital, without a vessel of any sort or kind being implicated.

But there is, Sir, another great division in our science, which, including, under the comprehensive denomination Embryology, a great variety of important inquiries, has,

in these last years, received a vast accession of facts; indeed, it might almost, without using an exaggerated expression, be said to have experienced a new creation. This study has at all times engaged the attention and stimulated the industry of philosophic anatomists, and for this sufficient reason, that, by revealing the primitive types of the various organs, it enables the observer to distinguish between the incidental and the essential. This has been, and will continue to be, the great and lasting interest of the inquiry with reflecting minds. But the admirable and extended researches of late years have placed the whole subject of embryology in a new, and, as regards the practitioner of medicine, in a most important light, by demonstrating the almost marvellous unity, which runs not only through the lower grades of the animal kingdom, but also pervades the various classes of the mammalia. To insist upon the importance of never losing sight of this great fact of organic unity, may indeed to some appear trifling or superfluous; but late experience, and especially the admirable researches of Professors WEBER and SHARPEY, have plainly shown us, in the instance of the placenta, what a penalty, in the shape of prolonged ignorance, disappointment, and angry discussion, might have been avoided, if unity of structure had been years ago taken for our guide.

In another division of embryological research, the inquiries of one of the most profound anatomists in Europe, Professor E. H. WEBER, have shown, in connexion with some lately recorded cases of hermaphroditical formations, that the most unusual, and even *bizarre* deviations from the ordinary rule, like the perturbations in the planetary movements, often afford the clearest confirmation of a general law. The structure discovered by this original observer, the *vesica prostatica*, or *utriculus virilis* as HUSCHKE proposes to call it, is a most remarkable

demonstration of organic unity, and will evidently serve not only to explain the complex appendages of the cervix vesicæ, as seen in the males of so many mammalia, in some of which it is clear the developed and bicorne utriculus virilis has been mistaken for the so-called vesiculæ seminales, but will likewise furnish the last link required for a satisfactory theory of hermaphroditical formations. As this subject is so interesting, I may call attention to the fact, that the Hunterian collection is, for a well-known reason, particularly rich in specimens illustrative of WEBER'S theory.

Another and a totally unexpected revelation of the same kind, has lately been furnished in the remarkable researches of STEENSTRUP, concerning the propagation of animals by what he terms alternating generation, a most curious process, which reconciles many anomalous forms of reproduction; among the rest, even those of bees and ants, by showing that they are nothing more than particular instances of a principle widely operative among the simpler classes of the animal kingdom, of which the practical observations of SIR JOHN DALYELL offer a most interesting confirmation.

The consideration of the vast improvement that has been, within so limited a period, introduced into the study of anatomy, even thus briefly noticed, has led me so much further into detail than I had anticipated, that I can merely glance at one or two of the most important of the additions that have been made to physiological science. Among the prime questions of the animal economy, there are few, if any, points of higher moment than that which concerns the relations existing between the vital powers and the molecular and chemical constitution of their organic instruments. We have at present a much clearer insight into these interdependencies than had hitherto

ever been obtained. Thus, in the vegetative existence, we can distinctly trace the new organic matters introduced into the interior of the system, through many, and in not a few instances, through all their manifold and important changes, till at length, having served their purpose, and constituted for a time a component part of the machine, they are cast out to be replaced by new supplies. That there is an incessant molecular destruction, or, to speak more correctly, mutation of the living body, is indeed no new truth, since it has been known from the infancy of science. "Life," to borrow the eloquent language of CUVIER, "is a continual vortex, of which the direction, all complex as it is, remains constant, as well as the kind of molecules propelled by it; but not so the individual molecules themselves which change without cessation, so that the actual matter of a living body, although it is the depository of forces which will constrain future matter to march in the same direc tion with itself, will soon be there no longer."

But it is a very different thing to know the general fact of this eternal change, and to be able, as we now are, by the aid of organic chemistry, to trace each act of the metamorphosis; to be able precisely to define what becomes of the saccharine and fatty principles of the food; to be able to follow the albuminoid matters, the phosphorus, the earthy, alkaline, and metallic salts; to have a clear perception to what particular class of organs they go; how they are used up in the production of different kinds of force, or in the formation of various secretions; and finally, to find in the very débris and excreta of the body the sure and certain measure of the vital action itself. It is a great fact to know that no force is generated, that no heat is evolved, that no motor power is produced, that no nervous action takes place, nay, that even no thought passes through the mind, without equi-

valent changes in the form of the organized materials of the frame. The physiologist obtains hereby a clearness of conception as to the most occult processes of life, which is strongly felt by all who possess it, but which, in the absence of all the extended knowledge out of which it springs, is difficult to convey to others by mere description. He is, for example, by one simple distinction thus enabled to separate the multitudinous organs of the animal body, leaving out of the category, for the moment, the mere preparing organs, like the glands, into two broad and distinct classes, according as they are the generators or the mere recipients or transmitters of force: he readily recognises the cause of the large supply of blood sent to the producer of the motive force—the muscle, and the comparative absence of vascularity in the mere passive organs of motion; and, in this way, is prepared for that beautiful instance of design revealed by the microscope —the looping back and the return of the blood-vessels, when, reaching the end of the muscle, they refuse to enter its tendinous appendage; and further, even when passing to such a subordinate group of organs as the bones, cartilage, and tendons, he finds, in the precise parts they have respectively to perform, the reason of the varying supplies of nutrient matter they demand and receive. All these principles, which have given an interest and a meaning to chemistry, as applied to the analysis of animal structures, it never before possessed, are among the highest truths of organic science; and it is now plainly seen must, in all subsequent time, constitute one of the prime means of interpreting vital phenomena, whether these be healthy or morbid.

But it is also evident that a most essential adjunct to organic chemistry is microscopic observation; and it is this combination that has facilitated the investigation of some of the most delicate processes of the animal economy.

Our acquaintance with the properties of the nucleus of the organic cell has been elucidated, for example, by the test of acetic acid and the observed effects, as in the case of the nucleated blood-disc of the oviparous vertebrata. The distinguished German physiologist, Huschke, has given us another of these delicate tests, in the instance of the hepatic cell, where he found, by the addition of nitric acid, that the yellow tint of the bile around the nucleus, noticed by other investigators, became deeper. These and all other researches show further the supreme importance of the cytoblast, the high merit of first pointing out which, belongs to that eminent physiologist, Dr. Martin Barry.

After the great principle of nervous conduction had been firmly established, it became a point of the highest moment to determine the true limits of consciousness. The founder of scientific neurology had indeed himself, by clearly marking out the distinction between the respiratory and voluntary movements, given a most important indication in the right direction; but it was reserved for my distinguished friend, Dr. Marshall Hall, to discover, as a purely independent force, co-ordinated by special structures, and regulated by special laws, that widely operating power which is centred in the spinal system. It is a curious coincidence, that nearly at the same time, when, by the discovery of the organic cell, the actions of the vascular system, till then held to be supreme in the vegetative life, were reduced to their real and secondary sphere, the mask of sensation, which had, in the higher animals, and specially in man, so long concealed the essential character of a vast number of nervous phenomena, was taken away; thereby enabling the physiologist, for the first time, to obtain a true insight into the extent of cerebral agency, as exhibited in the various tribes of animated beings. Having distinctly

recorded my conviction as to whom the high merit of reducing the scattered phenomena, observed by preceding inquirers, into one harmonious and complete system is due, and of establishing the principle on which they depend, it forms no part of my present purpose to enter into the discussion to which this discovery has given rise; nor is it needful, amidst the general recognition of the splendid results that have already flowed from these researches, to point to any of these individually.

I am, however, desirous of stating an opinion I have long entertained, that, notwithstanding the total change which has by these means been introduced into physiology, the agency of consciousness is still not reduced within its true and proper limits. That there are, for example, many cases of muscular excitation not involving consciousness, which are not comprehended, or even noticed, although of frequent occurrence, is certain. For example, if a person be either sitting or standing upright, and perfectly motionless, at each beat of the heart, when that organ is tilted forward against the wall of the chest, and at each inspiration, accompanied by the advance of the viscera, the centre of gravity must necessarily be changed; and to preserve the equilibrium a corresponding exercise of the spinal muscles must take place. Now, how are these motor organs stimulated? No one in the present day would affirm this to be by the will; then the spinal centre must be excited to action. So, again, in that curious affection anæsthesia, although the loss of sensation is said to be the cause of the peculiar diminution of the muscular power; this ought rather to be attributed to the deprivation of the spinal force, which, in the normal actions, is excited by some subtle impression connected with simple gravitation, operating upon what are called the sentient fibrillæ, but which it would be preferable to term simply the centripetal nerves, with which

all muscles are for this very reason supplied. If it be objected that these are too refined speculations, it may be answered, that, in investigating the ultimate actions of the nervous system, the difficulty is to attain to the necessary degree of refinement. How subtle, for instance, is the relation existing between the true sentient nerves and the brain. What is the nature of the impression, which, in the act of perception, is presented to the mind? does the latter take cognisance of the qualities of external objects or of the altered state of the nerve? A vast variety of clearly-ascertained facts corroborate the view so ably advocated by Professor MÜLLER, that in all sensation, whether objective or subjective, the percipient act invariably consist of the mind becoming acquainted with the peculiar condition of the nerve of sense, so that we have no knowledge except mediately, either of the bodies around us or of their qualities. It may indeed seem to be a more simple and direct mode to suppose that the qualities of matter themselves are the immediate objects of perception, and that the mind, for instance, looks out through the optic nerve and eye, as through a telescope; but this well considered is not a satisfactory explanation, as in the case of hearing becomes sufficiently apparent, for what is there in common between the vibratory movements or waves which impinge on the acoustic nerve, and the sensation called sound? The ultimate nervous actions being thus intricate and involved, it is evident how vast a step has been gained by separating definitely and for ever, the whole series of phenomena called spinal from those of true consciousness. This indeed, in a being like man, affected by absorbing and ever-recurring sensations, is the sole clue, both in health and disease, to avoid those mazes from which, wanting such a guide, even the very masters of our science did not know how to escape.

I have endeavoured, Sir, in the preceding remarks, to select a few of the more striking and distinctive features, by which anatomical and physiological science is at present characterised; and, unless I have entirely failed in the object I had in view, it will be apparent, that not only does the amount and kind of knowledge now possessed entirely surpass that of any former period, but likewise that the frame of mind and the aims of physiologists have experienced a marked and most beneficial change.

Although it forms no part of my present object to enter into the whole of that comprehensive and fundamental inquiry, which concerns the true nature of the forces that operate in animal bodies, and the relations existing between them and the material instruments through which they are displayed; yet, as I am anxious to submit some general remarks on the guiding principles which must ever be kept in view in physiological investigations, several of which have already been incidentally noticed, some allusion must necessarily be made to this intricate subject.

The first and most obvious circumstance that strikes an ordinary observer, in contemplating the complex phenomena of a living animal, is, that everything seems to be peculiar and different from what he has been accustomed to notice in other bodies, whether these are common inorganic substances, or of an organized class, as vegetables. But to one who has obtained some insight into the matter, it soon becomes apparent that many of the actions of the animal are like those of the plant, and even resemble the phenomena of physics and chemistry. That the animal body should, both as regards its constitution and its actions, be subject, more or less completely, to the ordinary laws of matter, can indeed be no ground for surprise, when it is recollected

that it contains no new elementary substance; that the peculiarities, as regards the material constitution of the frame, relate to the secondary, not to the primary, forms of matter; and, especially, that we constantly encounter, in the various parts of the animal economy, incontestable evidence of proceedings and contrivances, which find their counterpart, most imperfect it is true, in the laboratory of the chemist, and in the workshop of the mechanic.

As the interests of science require me to explain all this, and to show the intimate relation that exists between vital action and the ordinary forces of matter; and as, further, the whole progress of discovery shows how universal is this connexion, I feel it incumbent on me distinctly to explain that, in what I am about to state, I allude strictly and entirely to the life of the body, and in no degree to the spiritual part of our nature, which I regard as an essence totally distinct from the bodily frame.

With this explicit and all-important reservation, it must be regarded as a fundamental truth, that physical and chemical forces lie at the very bottom of all vital action, or, to borrow the philosophic expression of a most distinguished member of our profession, Dr. Arnott, that life is a superstructure on physics and chemistry. And this is not to be received in a general way, as a point which, although necessary to be known, when once admitted is then to be laid aside, allowing all the attention of the observer to be concentrated on the peculiar or living phenomena; the fact must be kept prominently and incessantly in view, whatever function be the subject of investigation.

Moreover, it is to be understood that nothing but the most accurate and refined kind of physical facts will suffice. It would not, perhaps, have been anticipated, that the delicate experiments of Lavoisier and Laplace,

on the heat produced by the combustion of a given quantity of hydrogen, could have any special interest for the physiologist; and yet it is now known that certain errors in the conclusions drawn from those researches for a series of years, during which the objections of DULONG and DESPRETZ were received, caused the true explanation of the production of animal heat to be held either in doubt, or even, joined to other circumstances, to be entirely rejected.

If this kind of knowledge be an indispensable condition of a successful research in the comparatively simple phenomena of the vegetable kingdom, and of the lower animals, how immeasurably more important does such a principle of procedure become, in the case of the human economy, where, in the midst of an almost infinite multitude of superadded and secondary organs and functions, the more deeply lying but fundamental properties are constantly in danger of being overlooked. In stating this a position is assumed, which I regard as being one of the most essential truths of physiology; it is this—that in ascending from the lower to the higher forms of matter, from inorganic matter to vegetables, from vegetables to animals, be the physical and chemical forces what they may, and, however much they may be modified by concomitant conditions, or masked by being associated with more peculiar, that is, vital forces, they never change, in any degree, their essential characters; the whole ascending series, from the simplest mineral to the highest animal, thus presenting superaddition, not substitution.

The same remark that is here made, in respect to the principle displayed in regard to physical and chemical actions in animal bodies, strictly applies to the ascending scale of organized structures and their endowments. But as doubt still exists as to the universality of this

principle, I am desirous of stating what I feel assured is the true view of the case. The proposition here assumed as being of universal application in the organic creation, I would thus state:—When in the ascending scale, a new system of organs for the first time appears, its influence as to essentials is invariably restricted to the circumstances which have led to its introduction; so that however much it may modify, in a secondary way, those organic structures which pre-existed, or which, in other terms, were possessed by the higher, in common with the lower, class of beings, the essential properties of such pre-existing structures remain unaltered and intact—it is here, as in the case of physical and vital forces, superaddition, not substitution. For instance, with respect to the nervous system, which for various reasons I prefer to select, when this first makes its appearance, it has essentially and fundamentally only reference to the phenomena of sensation and volition; that, in consequence of such a superaddition, modifications, often of a most varied and extensive kind, are made in the pre-existing organs and their actions; and further, that parts of the nervous apparatus itself may then become associated with the functions of those organs is most true, the investigations into the extent and character of these secondary relations, forming, in fact, a large part of physiological study. If, then, in certain classes of the simpler animals, digestion, respiration, secretion, the maintenance of a peculiar temperature, nutrition and reproduction, are accomplished completely and purely by the forces which operate through organic tissues, having no nervous nor, we may add, vascular system, we may be assured that the essential part of all these functions will depend on the same forces, notwithstanding the introduction of nerves and vessels.

I am aware that the position here assumed is in oppo-

sition to views extensively entertained, and, among others, by a physiologist, for whose judgment I have a high respect, the Professor of Surgery in this College. In the valuable lectures delivered by that gentleman on Abnormal Nutrition, it was assumed "that in ascending development, as one system after another is added or increased, so the highest, and highest of all the nervous system, would always be inserted and blended in a more and more intimate relation with all the rest;" and various cases were then adduced to demonstrate the direct influence of the nervous power upon the formative processes. These arguments have, I must confess, in no degree shaken my conviction; and this being so, I will take the liberty of adding, that unless this fundamental unity be admitted as a fixed and immutable truth, the study of organization can never ascend into the class of the more exact sciences. Such being, in my estimation, the importance of just conceptions upon this point relating to physical forces, I would crave permission to give some illustrations which may serve to put the whole principle in a clear light.

The blood is regarded, and properly, as being immediately connected with all vital action, in fact, as being literally, as well as figuratively, the life. But it is in a peculiar degree dependent on physical causes for many of its most essential phenomena. There is not, in the whole range of physiology, a more beautiful or masterly series of experiments than those of HEWSON on the endosmotic processes, which he so clearly demonstrated in the red corpuscles. Thus, when placed in water, he saw these bodies giving up their colouring matter and taking in water; he detected, in fact, the double current of DUTROCHET, and who that is acquainted with the philosophic bent of his mind can avoid the impression that if a life so valuable to science had been longer spared,

he would, by half a century, have anticipated the great discovery relating to the powers of organic membrane. Nay, he was treading on such high ground, though scarcely aware of it, that in the midst of his speculations concerning the vesicle and central particle of the blood-disc,—how little comprehended by his contemporaries, witness the silence in which for so many years they remained,—he was on the very verge of one of the great achievements of modern science—the discovery of the nucleated cell.

I need not point out, Sir, to you, who through a long and distinguished career have inculcated the importance of submitting experience to the guidance of science, and who have so well appreciated the valuable assistance afforded by minute observation in solving some of the highest problems of pathology, that late research, by demonstrating the occurrence of a series of subtle physical and chemical changes in the blood-corpuscles, has given great significance to the facts of Hewson. It has been ascertained by Dr. Emmert, a German physiologist, that when an inflammatory stasis is brought about, the blood-discs give up their cruorine to the abnormally liquefied plasma, and thence to the surrounding tissue, thus tinting them, and clearly assisting in the production of one of the technical characters of inflammation, redness; a minute and interesting process, which has been much elucidated in this country, especially by the observations of Dr. Owen Rees.

The influence of chemical action is also equally striking. If an animal be the subject of asphyxia, it is known that some particular cause induces a stoppage in the capillary circulation of the lungs. How difficult it has been to assign the true nature of this phenomenon, which is the immediate source of all that follows, the records of physiology prove; but it has at last been

satisfactorily established that it is owing to the want of oxygen; and the exact disturbance which occurs may be inferred from the important fact, for which science is indebted to that distinguished physiologist Mr. Wharton Jones, that when a stream of carbonic acid gas is directed against the blood-vessels of the lungs of a living frog, the red particles are attracted to each other and to the walls of the capillaries, and thus induce that fatal stagnation in the retia mirabilia, which is the efficient cause of all the mischief.

All this is most suggestive, by showing that any, the most subtle, changes in the physical and chemical condition of the blood-cells, by modifying their repulsive and attractive forces, will potently affect two of the most vital actions of the body, as they have been often interpreted, respiration and circulation.

It is a natural transition to pass from the blood itself to the minute capillary tubes through which it is transmitted in the ultimate divisions of the vascular system. Although it would not *à priori* be expected that these minute vessels, the phenomena of which it has been so much the custom to regard as of a peculiar vital nature, are those in which physical laws would have much place, yet minute observation has shown that this is the fact. In the discussions of that much vexed question whether the capillaries had or had not vital powers by which they modified the general force of the circulation, upon which it is not necessary now to touch, one of the most essential facts of the whole vascular action was overlooked; it is this, that the mechanical arrangement of the tubes in each different organ of the body is so contrived as to modify the propulsive force of the heart, in consequence of which a local and peculiar kind of circulation is established in each particular part, according to its requirements. This fixed but adapted framework stamped in

the very act of development on the ultimate division of the circulatory organs is so definite and precise, that the anatomist on seeing the minute vessels under the microscope can predict to what particular class of organs they belong. The mechanical disposition to which I have referred may be briefly expressed by stating, that the collective capacity of the capillary system varies in each organ, when compared with the area of the terminal arteries with which it is associated; and as the capacity of circular tubes enlarges in the ratio of the squares of the diameter, and as friction increases in the inverse ratio of the same measurement, we have the necessary data for determining the relative velocity with which the blood moves in the various organs. Hence the necessity for those admeasurements which have been accumulated by so many observers, and which to many persons may seem to have no application.

As an illustration of the vast importance of the principle in question, I would adduce the pulmonic circulation, which corresponds in time and quantity, though not in space, with the systemic circulation, an equality which is brought about, partly, it is true, by the diminished force of the right as contrasted with that of the left ventricle, but also very importantly by the vast aggregate area of the retia mirabilia, spread out over the air-cells. Another subordinate but still mechanical provision is also operative, the absence, namely, of that layer of the liquor sanguinis which, in the systemic capillaries, is interposed between the red corpuscles and the walls of these minute canals, so that in the pulmonary plexus of vessels, it is solids moving over solids, instead of, as elsewhere, liquids upon liquids. It is the more important to insist upon this fact, that the pulmonic circulation does, as to the time occupied, and the blood transmitted, precisely correspond with aortic circulation, since it is the clue to

a multitude of abnormal phenomena connected with the circulation; and especially because it has been stated, in works of authority, that it is a matter of indifference whether the whole quantity of blood which traverses the system does or does not, in the same time, pass through the lungs. The conclusion above stated I formed from an examination of the splendid capillary network covering the air-cells, and from reflecting on the general principles of the circulation; and I have found subsequently, that that excellent physiologist, VALENTIN, had, on somewhat different grounds, arrived at the same conclusion.

These remarks, joined to what was observed in the former part of this Address, will, it is conceived, sufficiently show, that he who wishes to appreciate intelligibly and truly the phenomena of the animal economy, must approach them by the way of physics and chemistry; and it is not superfluous to notice, that the existence in the nervous system of a central source of power, with appended threads distinctly displaying, as in the galvanometer, a conducting and an insulating apparatus, plainly evinces that even these subtle organs form no exception to the general principle.

I would further observe, that every successive advance of exact knowledge demonstrates how exaggerated have been the notions hitherto entertained, respecting the extent and influence of the purely vital powers. Thus it is affirmed, that one and an essential object of the vital principle so called, is to give to the animal body a certain resistance against the operation of destructive chemical action. But much of this does not appear to be well founded. In the case of the stomach, for example, it is known, that during life it resists the solvent powers of the gastric juice; but, as we learned first from HUNTER, after death, if it happens that the organ contains food, the left end is frequently found

dissolved. The most obvious explanation of this phenomenon would be, that some vital power defends the stomach, during life, against the chemical solvent. But when carefully investigated, it is found that the solution takes place so rapidly as to affect the stomach whilst it is so far alive, that its muscular coat would respond to the galvanic stimulus; and, moreover, that even living animals, earthworms and leeches, introduced into the stomach, inclosed within perforated spheres, so that they were guarded from muscular compression, are dissolved by the gastric juice. These considerations point, then, to another explanation; and in place of elucidating that one among the many marvels of animal existence, the defence of an organized tissue against an agent expressly provided in the economy to act upon such substances, by any particular vital property, we should rather seek for the reason in chemical action resisting chemical action; or, in other words, it may be assumed that whatever degree of protection is required, it being recollected that this is only necessary when there is food in the stomach, for at other times the elements of the gastric juice are inclosed within the different orders of epithelium cells, is furnished by the defensive mucus of the organ.*

Warned as I am by time to bring these remarks to a conclusion, there is still one branch of organic science, comparative anatomy, which, especially in combination with embryology, is so essential to the enlightened study of human anatomy, that I must, Sir, solicit your indulgence whilst I briefly allude to it. It has been one

* Since this Address was delivered, I have read a very interesting case, confirmatory of the views here advanced. At the meeting of the Pathological Society, on February 8, 1848, Dr. Robert Barnes exhibited a specimen of extensive perforation of the human stomach, from post-mortem solution by the gastric juice. The body was examined twenty-five hours after death, and still retained warmth; rigidity was very slight.—*London Med. Gaz.* Feb. 18, p. 293.

object of this Address, to point out the assistance that may justly be anticipated from the full adoption of the great principle of organic unity, as a means of interpretation. But to render this available, the most extended researches are required; for, otherwise, some secondary and adapted form is liable to be mistaken for the typical and essential, to which, I need not remark, this doctrine of unity alone applies; and if one error of this kind be committed, the whole series is not only thereby vitiated as to any true generalization, but even, as we have so often witnessed, the most profound errors are sure to be the result. Now the only source from which the necessary number of discriminative illustrations can be obtained, is comparative anatomy,—a science which offers such clear, trustworthy, and, when rightly apprehended, such simple and yet connected analyses of structure, that it may be regarded as constituting the very mathematics of philosophic anatomy.

But there is another, and to those who are interested in the improvement of medical education, a most important consideration connected with this subject. From my own experience as a teacher, I have no hesitation in expressing my conviction, that no one circumstance has tended so much to cramp the mind of the student in respect to one of the most essential of his pursuits, than the practice, till late years universal, and even now but too general, of introducing him to whatever knowledge he may attain to in the science of organization, through the exclusive portals of human anatomy, where all is so elaborate, modified, and therefore obscure. On the other hand, there is such an unbroken chain of connexion linking together the various classes of organs in the animal series, and the successive additions and developments proceed by such short steps, that the observer is conducted from simple to compound, much in the same

way as the geometrician is led certainly, but almost imperceptibly, from the primitive and self-evident axiom to the final demonstration of a complex proposition. It is thus that while the student is obtaining a practical acquaintance with facts essential to the due comprehension of the human formation, he is at the same time acquiring that inductive frame of mind, which will be of invaluable aid in a science like that of medicine, where the phenomena, however arbitrary they may seem to be, observe, on the whole, a regular and definite sequence.

Although I do not dwell on the bearings of this pursuit, in relation to the philosophic study of organization in general, because it may be thought that these concern rather the naturalist than the physician, the period is, doubtless, approaching, when the highest applications and the widest generalizations of this elevating science will be deemed to be among the most essential requirements, as assuredly they will constitute the highest charm of a liberal professional education. It is no insignificant indication of the coming change that the profound researches of one, who by his genius no less than by that enduring and ever vigorous industry which knows no pause, is marked by common consent both as the successor and the peer of CUVIER, are followed with increasing interest by the professors of medical science. It is, indeed, a great fact in the teaching of human anatomy, that we can use the admirable nomenclature of Professor OWEN—neurapophysis, hæmapophysis, pleurapophysis, words which fall on the ear as embodying for the first time the deep truths of embryology and philosophic anatomy; that the terms homology, type, analogy, are become familiar as household words; that we can, without the fear of bewildering our hearers, hold up the archetype vertebra as the significant symbol

of one of the most sublime truths in nature, the all-pervading unity steadily gleaming forth, amidst the endless variety of adaptive forms, in the vast series of the vertebrate sub-kingdom. Terms like these, and the truths they embody, are expressive of the vast revolution that has been introduced into anatomical science, which has at length embraced, as a realized fact, the great conceptions of HUNTER, by making the whole organic creation serve as the fitting basis for supporting that which is at once the capital and the marvellous type of the mighty whole, the corporeal framework of man.

I must here bring to a conclusion these reflections on the study of normal anatomy and physiology; but in doing so I would, Sir, point out what your own scientific pursuits will induce you readily to admit, that the same general mode of procedure which has secured to one branch of organization such great results, must be equally beneficial in that other great division of our science which relates to morbid anatomy and pathology. The necessity for microscopic research, for chemical analysis, and especially for a careful application of the great laws and principles of the normal structures and functions, is at length fully recognised. Indeed the idea must suggest itself to all who have considered this question, that morbid anatomy, although it has contributed powerfully to the establishment of scientific medicine, yet, as formerly pursued, rather concerned the *débris* and broken-up fragments of tissues and organs, destroyed by long preceding disease, than the actual affection and disease itself.

There yet remains, Sir, a part of my duty to be discharged this day, which I approach with deep regret. Within the brief period that has elapsed since the last anniversary meeting, it has been our painful lot to

witness two most striking examples of the frail and uncertain tenure of human life, so striking, indeed, in one case, as to have excited a most intense and widely-spread sentiment allied to awe and amazement. In the midst of an honorable career, two of the most eminent members of our profession have been removed from among us by the hand of death. The highest honours that await those who are distinguished in the profession of surgery had been attained by those whose loss we now lament; both were members of the Council of this College; both had held the responsible office of teacher; both were attached as surgeons to large and important hospitals. They had thus extended opportunities of benefiting, by the direct appliance of their skill, the inmates of those noble institutions; whilst by instructing others designed to follow in the same steps, the stores of practical knowledge acquired in an ample field of experience, became subservient to the general good of this vast empire.

The late Mr. Liston occupied a large space in the public eye; he was, in truth, marked out as one of the first surgeons of the day, not only in England, but likewise in foreign countries; and, as a bold and skillful operator, he had few competitors, and no superior. Although I had the honour of his acquaintance, and, indeed, was under obligations to him for much kind attention rendered to one most nearly connected with myself, yet not having enjoyed any personal opportunities for forming a just estimate of his professional career, I have thought I should best discharge the tribute due to his distinguished merits, by presenting to you, on this public occasion, the estimate placed upon them by one who, during a series of years, had watched his progress, and rejoiced in his success. Through the kindness of a mutual friend, I have been favoured with some most

masterly remarks illustrative of the more salient points characteristic of our lamented colleague, by the distinguished Professor of Surgery in the University of Edinburgh. So graphic indeed is this sketch, though hastily penned, and so generous in its tone, that it would be an injustice, both to its writer and to the memory of him who has inspired it, if I withheld, or even clothed in more formal language, sentiments so creditable to the living, and so honorable to the dead.

In the first lines of this communication, and in three words Mr. MILLER seems to me to have revealed the secret of Mr. LISTON's high success: he observes of him "nascitur non fit." Herein we have the clue to all that follows; for, unless there are the natural aptitudes, intellectual and physical, stamped innate upon the man, he rarely, if ever, soars above mediocrity. The high resolves, so often revealed in early youth, the indomitable energy that only strengthens in the face of difficulties before which more ordinary characters would quail, that inward consciousness of power, the very type of talent and genius,—all these are inborn not acquired.

Mr. MILLER thus speaks of his lamented teacher and friend: "He was a zealous enthusiast in his profession, from the first to the last week of his career. He was of very fine and sharp eyesight; and strong in hand and wrist. His hand a prodigy, huge to deformity, yet of the most delicate touch. It put me in mind of NAISMYTH'S steam-hammer, which drives a pile into the sea, or taps a nail or needle's point with equal precision and ease. Its perfect steadiness was something also uncommon; I never saw it shake, and I do not believe it ever did; it even wanted the ordinary tremor (like that of a steam-boat) which the arterial pulse causes. Its size and strength gave him great advantages in some operations—disarticulation of the jaw, for example; and

yet one saw it effecting the details of the nicest piece of autoplasty with extreme neatness. He had a strong mechanical turn, fond of instruments, as instruments, and very successful in changing them for the better. His great object was to simplify everything—instruments most especially—being convinced that the degree of their simplicity was the degree of their perfection. He had great courage, and at the same time great self-command *in arduis*. Trifles put him out of humour, especially in ordinary life; but grave accidents and untoward happenings, when professionally occupied, calmed him the more; like certain generals, martinets going into action, but cool, polite, and considerate the moment that shot and shell come thick around them. He had his feelings under tight command; a circumstance, however, which in no degree implied their absence. I have seen him rush from the operating theatre, and weep and sob like a child, after a great operation (lithotomy) which he had to complete for another surgeon; but, until the operation was over, there was no sign of softness. At his father's grave he showed much emotion.

"He had great self-reliance, for, feeling and knowing his powers, he never doubted them, and they, in turn, never deserted him. He had also great self-resource. In difficulties he had an admirable instinctive tact in extricating himself. Obstructed by some unforeseen event, in the middle of an operation, for example, he did not stop to think, or talk, or consult, but on the instant the thing was done necessary to overcome and meet the obstruction; and, in ninety-nine cases out of a hundred, after-reflection would only assure the on-lookers it was the best move that was made on the spur of the moment—that nothing else would have done so well.

"He had great powers of diagnosis; a touch and a

glance could do more for him than a day's fingering and prying for other people. His 'tactus' was most 'erudite,' so that we used to allege he had an eye in each finger's point.

"His medical treatment was extremely simple. He had great faith in the 'vis medicatrix naturæ,' and was very chary of thwarting this; nothing he detested more than the system of *drugging*, in truth, his face was set as a flint against quackery in all its forms."

Mr. LISTON introduced many improvements into the operative department of surgery; and was eminently successful in plastic surgery. He was very fond of morbid anatomy, and collected, at much expense, a valuable series of preparations, and, like all eminent surgeons, he was a zealous student of anatomy to the last. "As a teacher," observes Mr. MILLER, "he was not fluent or eloquent; but distinct, forcible, and eminently practical; strong pithy things were ever coming out, and nothing was common-place. He had great power in arresting the attention of his pupils, and of instilling into them some of his own zeal; and they all were much attached to him." I may add to this, that his writings, eminently practical, have had a wide influence, owing to their intrinsic excellence and extensive circulation, not only in this country but likewise in others. In America his 'Treatise on Practical Surgery' has been republished.

To the general correctness of this sketch, drawn by the friendly hand of an ardent admirer of this distinguished surgeon, many of those I have the honour of addressing, will doubtless give their testimony. That he was, like other eminent men, liable to occasional error, it would be inconsistent with truth to deny; for surgery forms no exception to the universal imperfection, which is impressed upon all things human; that these errors were

most rare, is the highest tribute to his science and his skill.

As Mr. LISTON was known to the professional, as well as to the general world, in an especial degree, as a bold and successful operator, the interests of science, no less than those of humanity, demand at my hand, in concluding these remarks, the explanation that, although when it was necessary he liked to operate, yet, when any doubt existed, he scrupulously avoided the use of the knife. So strongly was he, indeed, impressed with this sentiment in late years, that he observed, in writing to a professional friend in Edinburgh, "My principal business is to prevent people from operating."

May this be a warning to the junior members of our profession, who might otherwise, carried away by the dazzling success of the brilliant operator, forget that, after all, the highest triumphs achieved by the hand are but opprobia, which it is the great end and mission of scientific surgery to lessen or prevent.

The late Mr. MORGAN, although not occupying so prominent a place as the late Professor of Surgery in University College, was a most admirable surgeon and an excellent physiologist. Owing, however, to a certain reserve, partly natural and partly the result of circumstances, he was retiring in his general intercourse with the world; and this, joined to an utter aversion of all display, unquestionably prevented Mr. MORGAN'S high qualifications attracting that general notice which they merited and invariably received, among those who had the best opportunities for forming a correct judgment. A gentleman occupying the first rank in surgery* thus expresses himself: "Mr. MORGAN possessed great powers of perception, which gave him an acute insight into disease, a most ready memory that brought his past

* C. A. Key, Esq.

experience at once to his mind, and a firmness of purpose from which nothing could turn him, when his opinion was, on what he conceived proper grounds, once formed. With these mental qualifications was combined a dexterity of hand possessed by few and surpassed by none ;" to which I can add my own testimony, for Mr. MORGAN was certainly one of the most expert operators I have ever known. This perfect manual facility, without which it is impossible to shine in the theatre of a large hospital, seems to have been obtained in the instance of Mr. MORGAN by an early devotion to natural history, which prompted him to form, and in part to prepare the largest collection of British birds ever made, and which is now deposited in the Museum of the Philosophical Society at Cambridge.

I need not, gentlemen, point out to you that the qualifications I have described are the very attributes of a distinguished surgeon. Our lamented colleague was, moreover, characterised by remarkable clearness and practical intelligence as a teacher,—two of the most valuable qualities which can be brought into the professorial chair. He was, likewise, strongly impressed with the importance of what is termed medical surgery, and this he applied with great success, especially in relation to the eye.

To the high scientific attainments of Mr. MORGAN, I can with perfect truth bear my own testimony. All his published writings bear the impress of much acumen, of original observations, and of a philosophic mind. His experimental inquiries into the *modus operandi* of poisons, undertaken in conjunction with Dr. ADDISON, contain much valuable matter ; the theory therein advanced, rests on strictly physiological principles, and is worthy of careful consideration, not merely in relation to the immediate subject of the work, but also as connected

with the operation of noxious impressions on the system generally.

The most interesting of these scientific contributions is, however, the admirable account of the mammary organs of the kangaroo. Many of the most important and remarkable of the peculiarities which distinguish this class of marsupial animals, were first accurately described by Mr. MORGAN, especially the inferior mammæ and the remarkable compressor muscle forming a part of that most beautiful series of contrivances, including the peculiar conformation of the tongue and the fauces, which was subsequently so fully investigated by Mr. OWEN.

In private life Mr. MORGAN was beloved and esteemed by all who enjoyed his friendship. One who is himself no less distinguished by scientific attainments, which have secured him an European reputation, than by those private virtues which have commanded an universal esteem,* in a communication with which he has favoured me, observes of his lamented friend, that he was ardent in his affections, liberal as to his benevolence, and of an open and generous nature. When it is known that to these traits were joined an entire truthfulness and child-like simplicity, so often the accompaniment and the ornament of a talented and refined mind, we shall not be surprised that his friendship was highly prized, and that his death was most sincerely lamented.

Having discharged this most painful duty,—how imperfectly none can feel more vividly than myself, I must, Sir, bring to a conclusion this Address, in which I have trespassed so largely on your time and attention. The general inference which we are justified in drawing from the whole of this exposition, must be regarded as most

* Thomas Bell, Esq.

encouraging for future progress; and, among the many circumstances that justify the most sanguine anticipations, not the least is the zeal, which so many among our intelligent students, so far at least as my own experience enables me to form an opinion, display in the cultivation of the higher branches of organization. How, indeed, can it be otherwise when the absorbing interest of the inquiry is considered? Anatomy as formerly cultivated, the limited part of it styled surgical excepted, consisted for the most part of meagre descriptive details, which, wanting all cohesion and signification, as parts of a mighty and harmonious whole, could engage in their acquisition, none of the higher faculties or aptitudes of the mind: they were, consequently, but too often merely committed to memory as an acquisition necessary to the passing of an examination, rather than as a treasured possession, which was to serve as the steady light in all the mazes and difficulties of a professional career. But at present what a contrast does the subject matter presented to the student of medicine offer. In the first place, when he knows that in the animal body everything is regulated by unity and law, he enters upon the inquiry with the assured conviction, that in the midst of all the outward intricacies of the various organs, there is a beautiful and intelligible order; so that once having the clue to this marvellous labyrinth, no parts or combination of parts, can present themselves so complex, but that he has a clear perception of the goal to which they lead. This is a vast conclusion, since experience shows that the great obstacles which oppose the successful prosecution of knowledge, do not so much depend on the multitude or magnitude of the facts to be acquired, as upon the distaste, or even despair, which is created, when, owing to a defective procedure, their meaning and application are not comprehended.

There is, moreover, an advantage equally important with the preceding, which is not, however, appreciated; or which, it might rather be said, is directly opposed to a very common impression; I allude to the admirable simplicity of the structural anatomy of the present day. How readily does the mind apprehend and retain such truths as these; that all secerning organs, whether these are serous membranes, mucous membranes, or glands, have essentially but one structure, that of the epithelial cells; that all organs, muscles, nerves, cartilage, and even epidermic parts, bear one definite relation to the blood-vessels, all being extra-vascular; that formations apparently the most dissimilar,—the salivary glands, the lungs, and the liver,—are formed upon one common and readily comprehended plan. It must further be remarked, that not only are the leading principles thus stamped with that highest character of truth, simplicity, but likewise that the evidence by which they are made apparent to the mind through the senses, is equally plain and satisfactory. It may be unhesitatingly affirmed that of all the means yet devised for demonstrating the structure of the human body, none are comparable, as to exquisite clearness and distinctness, with those afforded by well-prepared microscopic specimens. No dissection, however minute, no preparation which is the mere production of the scalpel, can approach in delicacy, definition, or beauty, to the results of minute injection or successful sections. In support of this assertion, I can adduce my own experience as a teacher, and if further confirmation be needed, I may appeal to those who have availed themselves of the admirable microscopic demonstrations delivered within the walls of this theatre. It is a source of sincere congratulation that such ample means of illustration have been thus provided; and as these Lectures were established by the Council of this College, before I

had the honour of being one of its members, I may, perhaps, without impropriety, be permitted to convey to you, Sir, as the representative of that body, an expression of thankfulness, not, I feel assured, confined to myself alone, for the adoption of a measure so well calculated to promote a taste for the higher branches of physiological science. It is also a cause of much satisfaction to know that the advantages derivable from the extensive microscopic collection now added to this Museum, a collection to which Europe offers no parallel, will soon be more widely diffused through the medium of a descriptive and illustrated Catalogue, which is, by the direction of the Council, being arranged for publication by my friend Mr. QUEKETT, and which, thanks to the zeal of that gentleman, is so much advanced that the first volume, including the elementary tissues, will be published before the conclusion of the present year.

Although so much has been advanced in favour of these pursuits, their purest and most elevating influence yet remains to be noticed. To him who, in a teachable and humble frame of mind, engages in the study of organic science, how glorious a scene is opened! In the vast circle of living beings, he is, in virtue of his own faculties, enabled to comprehend, though as through a glass darkly, the counsels of the Most High; he is permitted to witness, in this external revelation of divine power, which so strikingly contrasts with all mere human works, a wondrous and endless variety of results springing from a few simple, but all-pervading forces, which, although infinitely refined and subjected to the guidance of the immaterial spirit, are equally operative in the corporeal frame of man, as in the humblest plant or simplest mineral.

But, rightly interpreted, these high pursuits have a

bearing more precious in the fallen estate of our nature; since they reveal with a clearness which no argument can touch, and no sophistry can shake, the sublime spectacle of a creation ruled by order and by law; in which chance and accident have and can have no place; where each atom, though never seen by human eye, is known to have its exact position preassigned, and its endowment predetermined; where each component element of the mighty whole, though so subtle that the mind is incompetent even to conceive of its nature, is yet so impressed with a fixed and unchangeable character, that the way in which it will behave, the conditions being known, can be certainly predicted. And all these evidences of the supreme subordination of phenomena to law, are not, it must be remembered, displayed in mere dead matter; they are as plainly revealed in all the varying and seemingly uncontrolled actions of animated beings.

These things being so, can any one, in the calm exercise of his judgment, imagine it possible, that in the highest realm of creation, in that which is placed supreme over all, there should be no order, no law? Is it reasonable to suppose, that whilst the whole material world is duly and mathematically regulated, that in that, which it would be mere weakness to deny is a part of a connected whole, that in the circle of the moral phenomena, disorder and chance should for the first time be introduced, to mar and disfigure the harmony of all the rest? Such an exception, such a deformity, would, if true, be without a parallel in the universal creation, so far as it is, in this passing hour, permitted to man to know. Having, then, a conviction that there are such things as moral laws, where, it must be asked, are we to seek them? In the midst of the infirmity and fickleness of the human mind, which, changing with every age, and vacillating

with every clime, is never alike in any two countries nor in any two epochs; nay, which is so frail, that the same individual scarcely views the same subject in the same aspect for two short consecutive hours? If, then, man is not, and from his very constitution cannot be, a law to himself, we must look elsewhere for the moral code: we must turn to the sacred volume of Revelation, wherein we shall discover laws as perfect and principles as fixed for the guidance of the spiritual nature of man, as those which rule the phenomena of the material world; where, in fine, aided by the Divine grace, and prepared by a fitting humility, each and every one of us may hope to come to that "true light which lighteth every man that cometh into the world."

THE END.

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